

A REVIEW OF HUMPBACK WHALE CATCHES BY MODERN WHALING OPERATIONS IN THE SOUTHERN HEMISPHERE

K.P. FINDLAY

Findlay, K.P. 2000 12 31. A review of humpback whale catches by modern whaling operations in the Southern Hemisphere. *Memoirs of the Queensland Museum* 47(2): 411-420. Brisbane. ISSN 0079-8835.

Catches of humpback whales in the Southern Hemisphere are reviewed from a number of sources, along with numbers of catcher vessels which operated on each whaling ground, where data were available. Catches amounted to >200,000 whales and can be divided into four groups: 1) pre-1917 coastal whaling from shore stations and floating factories; 2) Antarctic and low latitude pelagic and coastal catches reported to the Bureau of International Whaling Statistics (1923-1963); 3) post-1942 coastal catches largely centred in Australian and New Zealand waters; and 4) other catches, including those of the *Olympic Challenger* and the Soviet Antarctic whaling fleets. Crude catch per unit of effort (CPUE) indices were calculated as annual catch per catcher vessel for the Falkland Island Dependencies, African and South American whaling grounds. No CPUE indices could be calculated for the Australian grounds or the Antarctic pelagic whaling grounds. Catch trends in most grounds showed marked declines within the first decade of whaling, followed by no recovery. Marked differences in catch trends off both Gabon and Madagascar from those of other grounds off the west and east coasts of Africa respectively, suggest stock segregation in both areas. □ *Humpback whale, catches, Southern Hemisphere, modern whaling.*

K.P. Findlay, Oceanography Department, University of Cape Town, Rondebosch 7701, South Africa: 1 September 2001.

Southern Hemisphere humpback whales (*Megaptera novaeangliae*) undertake annual migrations from summer polar feeding grounds to winter breeding grounds in tropical and sub-tropical waters (Risting, 1912; Olsen, 1914; Harmer, 1929, 1931; Matthews, 1938; Mackintosh, 1942). Seven feeding grounds have been identified within the Southern Ocean (Mackintosh, 1942; Omura, 1973; International Whaling Commission, 1998), each linked to a breeding ground in coastal waters of either South America, Africa (including Madagascar), Australia, New Zealand or the islands of the southwestern Pacific Ocean (Kellogg, 1929; Rayner, 1940; Mackintosh, 1942; IWC, 1998). En route between breeding and feeding grounds humpback whales utilise the coastal waters of Southern Hemisphere continents as migratory corridors, a factor which made them susceptible to coastal whaling in tropical and sub-tropical waters from the first decade of the 20th Century.

Pre-exploitation size of the Southern Hemisphere humpback whale population was estimated at 90,000-100,000 (Chapman, 1974). Based on sightings in the Antarctic between 1933-1939, Mackintosh & Brown (1965) estimated the combined southern population of blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*) and humpback whales at 220,000 with a range of

142,500-340,000. Chittleborough (1965), using an estimate of 220,000-340,000 whales, and Mackintosh's (1942) assumption that 10% of the large baleen whales in the southern oceans were humpback whales, suggested that the Southern Hemisphere humpback whale population was in the order of 22,000-34,000 between 1933-1939.

MATERIALS AND METHODS

Brief descriptions of operations in each of a number of whaling grounds were sourced from the Bureau of International Whaling Statistics (BIWS, 1942-1964), Tønnesen & Johnsen (1982), Dawbin (1956), Best (1994), Best & Ross (1989), Goodall (1913), Chittleborough (1965), Williamson (1975), Budker (1954), Budker & Collignon (1952), Angot (1951), Olsen (1915), Ommaney (1933), Risting (1912), Omura (1973), Grady (1982), Hinton (1925), Barthelmess et al. (1997), Mackintosh (1942) and Zemsky et al. (1997).

Time series of catches from different localities were compiled from the BIWS (1942-1964), Best (1994), Dawbin (1956), Chittleborough (1965), Grady (1982) and Tønnesen & Johnsen (1982). Numbers of whale catcher vessels operating each year were obtained from the BIWS (1942-1964) for some whaling grounds and were used to calculate crude catch per unit of effort (CPUE)

indices, as catch per number of catcher vessels per annum. Indices were calculated for the Falkland Island Dependencies, southern African coasts, southern American coasts and Kerguelen Island. These CPUE indices must be considered crude and may be biased by environmental conditions (e.g. ice and weather), catch selectivity, differences in catcher vessel tonnage, operational limitations (including towing of carcasses to stations, availability of water) and catch regulations. No attempt was made to quantify these possible biases.

Given a series of catches (c) and associated catch effort (e) over time (t), the catch per unit effort (C) was calculated (as c/e). In the time series available, C generally decreases over time. Given the following assumptions, the decline in catch per unit effort (CPUE) can be assumed to reflect the extent of depletion (De Lury, 1947): 1) catchability of animals (the proportion of population caught by one unit of effort) is constant between seasons; 2) unit of effort is constant between seasons; and 3) the population is closed.

Under these assumptions, De Lury (1947) suggested that:

$$\log C = \log (kN_{(0)}) - kE \quad \text{and,}$$

$$C = k(N_{(0)} - K),$$

where E and K are the total effort and total catch, up to interval t , and N is the number of individuals in the population at time t . Plotting both the catchability (k) and the initial stock size prior to catching, $N_{(0)}$ can be estimated by elementary regression analyses of C against K . Regression analyses (of C against K) were carried out for the Falkland Island Dependencies and the African west coast (excluding Gabon), Gabon, and east coast (excluding Madagascar). The three assumptions may be seriously violated by biases in the CPUE indices expressed above as well as the open nature of the populations due to natural mortality and recruitment, and any changes in migration patterns over time.

Season Notation. In this text, year combinations such as '1910/1911' indicate a Southern Hemisphere summer season.

RESULTS

CATCH HISTORIES. Total catches for the areas north and south of 40°S are presented in Tables 1 and 2 respectively. Catches from South America are included in Table 1 regardless of latitude.

THE FALKLAND ISLAND DEPENDENCIES. Modern whaling of humpback whales in coastal

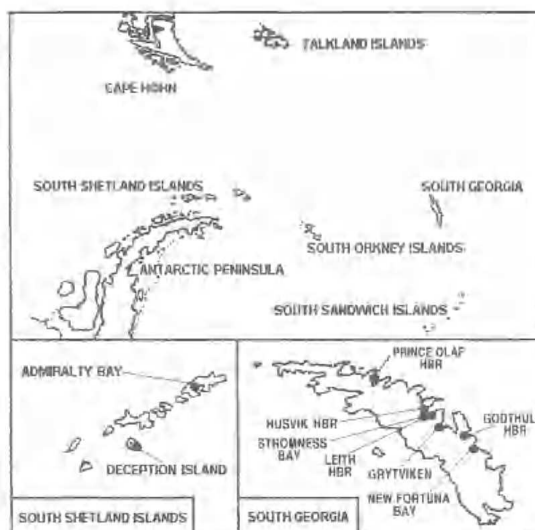


FIG. 1. Locations of shore-based modern whaling stations in the Falkland Island Dependencies.

waters of South Georgia operated from 1904-1955. Shore stations were established at Grytviken (1904-1962), Husvik Harbour (1907-1961), Stromness Bay (1907-1931), Leith Harbour (1909-1955), Godthul Harbour (1908-1929), New Fortuna Bay (1909-1920) and Prince Olaf Harbour (1911-1931) (Fig. 1). Moored floating factories were used at Husvik Harbour (1907-1911), at Stromness Bay (1907-1912) at Prince Olaf Harbour (1911-1916) and at Godthul Harbour (1908-1929) (Fig. 1). Catches of humpback whales were banned in the waters of South Georgia from the summer 1918/19 season, although some animals were taken each year between 1918-1921. This ban was reinforced in 1921, although relaxed by 1926/1927.

Whaling at the South Shetland Islands started in 1905/1906 when the floating factory *Admiralen* spent one month whaling in Admiralty Bay at King George Island. In 1906 the harbour at Deception Island was discovered and this became the centre of whaling at the South Shetland Islands. Catches prior to 1909/1910 were not well documented.

Whaling at the South Orkney Islands began in 1907/1908, although sea ice resulted in the operation being moved to the South Shetland Islands within this season. In 1911/1912 a floating factory with two catcher vessels operated in the region. Abundant stocks of blue and fin whales and adequate water and anchorage saw four floating factories (with six catcher vessels)

TABLE 1. Low latitude catches (north of 40°S) of Southern Hemisphere humpback whales by modern whaling between 1904 and 1974.

Location	Catch
Southern Africa (Total)	47134
Cape	1571
Namibia	1284
Angola	10027
Gabon	15158
Natal	9785
Mozambique	3128
Madagascar	6181
South American East Coast	1557
South American West Coast	1985
Australian West Coast	19557
Australian East Coast	8307
New Zealand	5224
Low Latitude Pelagic Whaling (Total)	9612
West Australia	7243
Gabon	2309
Peru and Chile	70
<i>Olympic Challenger</i> fleet	105

operating the following season. Three of these returned in 1913/1914, but results were so poor that only one remained in 1914/1915. Conditions at the South Orkney Islands were difficult due to ice formation from the Weddell Sea and the season was limited to 2-3 months a year. Such difficulties with ice formation in 1912/13 resulted in whales being caught along the ice barrier, the first attempts at 'pelagic whaling' in the Antarctic. Tonnessen & Johnsen (1982) note that whaling off the South Orkney Islands was important as it: proved that it was possible to operate within the pack ice; placed the idea of a slipway into practice; and generated considerable information on the relationship between ice, plankton and whale stocks.

Initially whaling at the South Sandwich Islands was limited to one season, 1911/1912, when 28 whales were caught. This was a failure and attempts were not repeated. Although seven licences were issued for whaling in the region, six licencees withdrew on hearing of the difficult conditions encountered by the other company. However, Tonnessen & Johnsen (1982) noted that in the 1920's many floating factories operated near the islands.

Whaling in the Falkland Islands started in 1905/1906 as expeditions to the South Shetland Islands visited en route to and from the whaling grounds.

TABLE 2. High latitude catches (south of 40°S) of Southern Hemisphere humpback whales by modern whaling between 1904 and 1974.

Location	Catch
Land Stations & Floating Factories (Total)	34683
South Georgia	24770
South Shetland Is	8879
South Orkney Is	405
Falkland Is	200
Kerguelen Island	429
Antarctic Pelagic Whaling (Total)	25393
Area I	1295
Area II	1537
Area III	7074
Area IV	11988
Area V	2405
Area VI	1094
<i>Olympic Challenger</i> Fleet	4554
Soviet Antarctic Whaling Fleet (Total)	38724
Area I	414
Area II	1364
Area III	1280
Area IV	2638
Area V	4861
Area VI	3332
Unknown	34835

A total of 34,265 humpback whales was taken from land-based stations and moored floating factories in the Falkland Island Dependency region between 1904-1963 (Table 2). Humpback whales formed the bulk of catches during the initial years (until 1914/15), peaking in 1910/1911 when 8,294 were taken. By 1916 catches had declined considerably (only 131 humpback whales were taken in the Antarctic in 1916/17), although their increasingly secondary importance to catches of blue whales must be noted. Catches of humpback whales from land stations in the Falkland Island Dependencies remained low until ceasing at South Georgia in 1955.

AFRICAN COAST. Modern whaling in South Africa began at Durban in 1908 after reports of the abundance of whales were received in Norway. By 1909 floating factories were operating off the west coast at Saldanha Bay. The success of the entrepreneurial whaling companies in south Africa in 1909 and 1910 resulted in a whaling boom in the region. By 1913, 11 floating factories and 17 land stations were in operation between Gabon (French Congo) and Mozambique (Portuguese East Africa), during which an estimated 7,263 humpback whales were

taken. The distribution of shore-based modern whaling stations on the southern African coast is shown in Fig. 2 (after Best, 1994).

Modern whaling in the waters of Madagascar probably began in the 1910 winter, although poor catches in 1912 resulted in abandonment by whaling fleets. Catches from this era are unknown. Humpback whales were caught to the south of Madagascar during the 1937 and 1938 seasons, and although the exact location of these catches are not specified by the BIWS, Budker (1954) noted they were some distance to the south of Madagascar. Such catches may have been from the Walters Shoal area where Best et al. (1998) have reported sightings of humpback whales. A further bout of humpback whale catches occurred off Madagascar in 1949-1950 (Angot, 1951).

Best (1994) estimated that over 31,000 humpback whales were taken off the southern African coast (excluding Madagascar) from 1908-1930, although there is still some uncertainty on the early catches off Angola, Mozambique and Gabon. As with catches in the Falkland Island Dependencies, humpback whales were the initial target, although by 1915 blue whales had become a higher priority. A total of 47,134 humpback whales was taken by modern land-based stations and moored floating factories off the southern African coast between 1908-1963, with 28,040 and 19,094 of these taken off the east and west coasts respectively (Table 1). A further 2,309 were taken by low latitude pelagic whaling fleets operating off Gabon (Table 1).

KERGUELEN. One Norwegian company (A/S Kerguelen) was granted a licence in 1908 for whaling and sealing of elephant seals in the waters of Kerguelen Islands. Whale catches were poor and although abandoned in 1911, sealing continued until 1914. A total of 429 humpback whales were taken during this time.

SOUTH AMERICA. Levels of whaling on the east and west coasts of South America were insignificant compared with levels at other continents (Tønnessen & Johnsen, 1982). The first humpback whale to be taken by modern whaling in the Southern Hemisphere was caught in the Straits of Magellan on New Year's Eve in 1903, and by 1905 a whaling station had been established at Punta Arenas in Chile. The success of this station resulted in the formation of a Chilean whaling company (Sociedad Ballenera de Magallanes) which operated at Deception Island (South Shetlands) in 1906. In 1906 a further company was established at Valdivia in

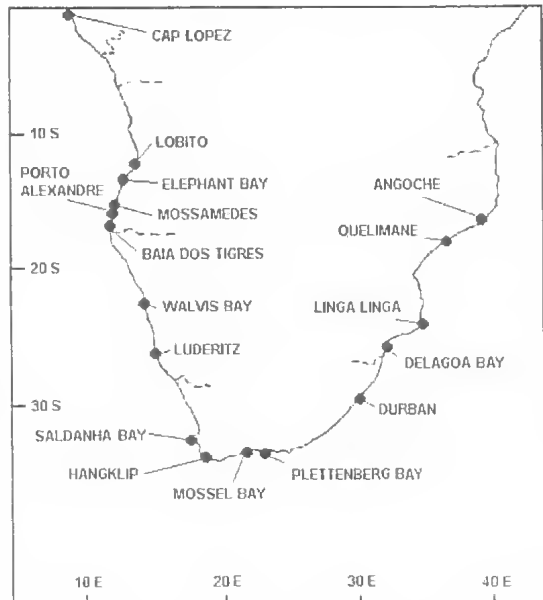


FIG. 2. Locations of shore-based modern whaling stations on the southern African coast (after Best, 1994).

Chile from where a shore station and a floating factory ship were in operation until 1913. In 1914 the floating factory *Sabraon* followed the northward migration of whales along the coasts of Chile, Peru, Ecuador and Colombia and caught 327 whales (almost exclusively humpback whales) over the period April 1914 - May 1915. The two companies were sold to the Sociedad Ballenera Corral S.A., just south of Valdivia, in 1913 and 1917 respectively.

Modern whaling of humpback whales in Brazil started at Costinha in 1910 (Williamson, 1975) or 1911 (Tønnessen & Johnsen, 1982). In the following year three companies were operating, one Brazilian and two Norwegian. By 1913 and 1914 the Norwegian companies had terminated operations. A second shore station was established at Cabo Frio in 1960, while modern whaling was carried out from Santa Catarina from 1952. It appears that the majority of humpback whale catches were made from the Costinha station.

Totals of 1,557 and 1,985 humpback whales were taken by modern whaling off the east and west coasts of South America respectively (Table 1). Catch records for Brazil are incomplete between 1929-1946 however, and possibly unreliable in certain other years. No attempt has been made to include the early 1905/1906 catches from southern Chile for which no species

identifications could be sourced. These totals in all likelihood include the 327 whales (almost exclusively humpback whales) taken by the floating factory *Sahraon* which operated off the coasts of Chile, Peru, Ecuador and Colombia in 1914.

AUSTRALIA (INCLUDING NORFOLK ISLAND) AND NEW ZEALAND. In 1909 the Norwegian consul in Sydney drew Norwegian whalers' attention to the abundance of whales in Australian waters, and by 1911 ten companies expressed interest in whaling operations. Of these, four never commenced, two operated on an experimental basis in 1912, one operated a floating factory at Jervis Bay, New South Wales between 1912-1913, while three co-operative companies operated at Albany and Point Cloates (Norwegian Bay) in Western Australia from 1912-1916. By 1913, authorities in Western Australia introduced catch regulations (Tønnessen & Johnsen, 1982) and the three co-operatives closed in 1916. The Point Cloates station operated again between 1922-1928, although profitable catches were only recorded after 1925 (Tønnessen & Johnsen, 1982). Shore-based whaling resumed in 1949 on the west coast, after a period of extensive whaling in Western Australian waters by foreign fleets between 1935-1939 (BIWS, 1964). Shore-based operations after 1949 were at Point Cloates (1949-1955), Carnarvon (1950-1963) and Albany (1952-1963) on the west coast and at Tangalooma (1952-1962) and Byron Bay (1954-1962) on the east coast and at Norfolk Island (1956-1962) (Chittleborough, 1965) (Fig. 3).

Modern whaling began in New Zealand in 1910 when a modern catcher vessel was acquired at Whangamumu, although a net fishery for humpback whales had operated there between 1893-1910 (Ommanney, 1933; Dawbin, 1956). A number of humpback whaling centres existed in New Zealand after 1911: Whangamumu (which closed in 1931); Kaikoura between 1917-1922; and in the Tory Channel of Cook Strait (including the Perano station) which took humpback whales until 1963 (Grady, 1982) (Fig. 3). Catching of humpback whales at the Tory Channel station was carried out from small (34ft) fast vessels operated by crews of two rather than from conventional catcher vessels. Light harpoons were fired from a small 32mm cannon to capture the animal, whereafter it was dispatched by explosive shell detonated from the catcher vessel.

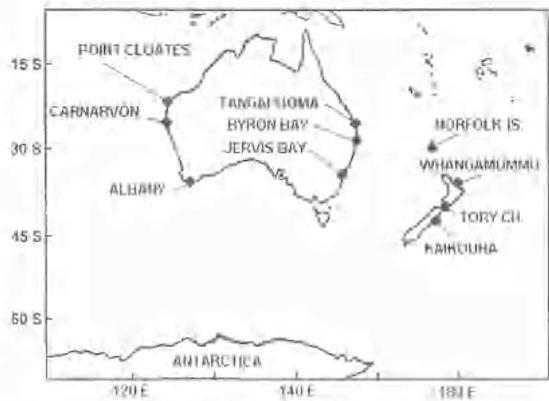


FIG. 3. Locations of shore-based stations in Australia and New Zealand.

Totals of 19,557 and 8,302 humpback whales were taken by modern land-based stations and moored floating factories off the west and east coasts of Australia respectively between 1911-1963 (Table 1). A further 1,870 whales taken in 1912 and 1913 were reported to the BIWS as from the coast of Australia and could not be allocated to a specific locality. A further 7,243 humpback whales were taken by foreign fleets off the west coast between 1935-1939 (Table 1). Catches on both coasts after 1949 were subject to annual quotas, which were met up until 1957 on the west coast and 1961 on the east coast. Chittleborough (1965) noted a rapid decline in catch per unit effort during this period and suggested, at least in the case of the east coast stock, that this may have arisen from substantial undeclared catches.

A total of 3,923 humpback whales were reported by Dawbin (1956) to have been taken by modern whaling (including the Perano's small boat whaling) in New Zealand waters between 1912-1955. A further 1,601 were taken in the Tory Channel between 1956-1963 resulting in a total catch of 5,524 humpback whales (Table 1).

ANTARCTIC PELAGIC WHALING. Pelagic whaling began in the Antarctic with a single season off the South Orkney Islands in 1912 and again in the Ross Sea in 1923/1924. Humpback whale catches over the period 1934-1938 were large and consequently the species was protected from pelagic whaling in Antarctic waters from 1938-1949 by the International Agreement for the Regulation of Whaling (ARW). A temporary relaxation of this protection in 1940/1941 resulted in a catch of 2,675 whale catches by the Japanese (who at the time were not members of the ARW)

in 1938/39 accounted for a further 883. From the 1949/1950 to the 1951/52 seasons, catches of humpback whales to the south of 40°S (and outside of the declared sanctuary of 70°-160°W) were limited to 1,250 each year, with a four-day grace period set after this catch was achieved. However, catches during the four-day grace period were high and from 1952/1953, catches of humpback whales in Antarctic waters were regulated by a limited (four day) season over the period 1-4 February. The 70°-160°W sanctuary remained in place until 1955/1956 and from 1954/1955 the waters south of 40°S and between 0°-70°W were closed to humpback whaling. From 1958/1959 the western boundary of this area was shifted east to 60°W.

A total of 25,393 humpback whale catches were reported to the BIWS by Antarctic pelagic whaling fleets between 1923-1963 (Table 2). This excluded the falsified Soviet catches reported to the BIWS between 1948/1949 and 1972/1973 (Zemsky et al. 1997, in IWC, 1997).

THE OLYMPIC CHALLENGER CATCHES. The Olympic Whaling Company S.A., registered in Montevideo, Uruguay, operated the *Olympic Challenger*, a Panamanian registered floating factory and twelve whale catcher vessels, some of which were registered in Honduras. As neither nation had ratified the Washington Convention the owners saw fit to ignore regulations. The *Olympic Challenger* whaling fleet operated in Antarctic waters and off the west coast of South America between 1950/1951 and 1955/1956 (excluding 1953/1954). Barthelmess et al. (1997) stated that it had long been noted that major discrepancies existed between the catch records submitted to the BIWS and true catch records, and provided an approximation to the true catch figures. Such approximated catch figures have been used in this review.

A estimated 4,554 humpback whales were taken in the Southern Ocean by the *Olympic Challenger* fleet between December 1950 and April 1956 (Table 2). A further 105 were taken off the west coast of South America in the winter of 1954 (Table 1).

SOVIET ANTARCTIC WHALING FLEETS. The Soviet Union operated four Antarctic whaling fleets between the 1946/47 and 1986/1987 seasons. The *Slava* fleet operated from 1946/1947 until 1965/1966; the *Sovietskaya Ukraina* fleet between 1959/1960 and 1986/1987; the *Yurii Dolgurukiy* fleet between 1960/1961 and 1974/1975; and the *Sovietskaya Rossia* fleet

between 1961/1962 and 1979/1980. Catches of humpback whales reported to the BIWS (in terms of Article VII of the International Convention for the Regulation of Whaling, 1946) were unreliable for the period 1948/1949 to 1971/1972 (Yablokov, 1994) and reported and true catches were presented by Zemsky et al. (1997, in IWC, 1997). Daily (noon) catch positions are known for only a portion of the *Slava*, *Sovietskaya Rossia* and *Sovietskaya Ukraina* catches, while positions of the *Yurii Dolgurukiy* were known only by IWC Areas.

Despite reporting a total catch of 2,700 humpback whales to the BIWS (in terms of Article VII of the International Convention for the Regulation of Whaling, 1946), the Soviet Antarctic whaling fleet caught 48,724 humpback whales between 1948/1949 and 1972/1973 (Table 2). Of these, 34,835 have no associated locality, while the remainder are designated by IWC Management Area (Table 2). It must be noted that a small percentage of these whales were possibly taken in the northern Indian Ocean or north of 40°S as reflected in the figures of catch positions of all species presented by Mikhalev (1997, in IWC, 1997).

CATCH PER UNIT EFFORT AND 'DE LURY' ANALYSES

Crude CPUE indices have been calculated for the Falkland Island Dependencies, the Southern African coasts, the South American coasts and Kerguelen Island from total catch and total effort (expressed simply as number of operating catcher vessels) per year (Fig. 4A-D).

Plotting of CPUE against total catch provides an estimate of pre-exploitation population size (De Lury, 1974). This has been carried out for the initial years of whaling in Falkland Island Dependencies (1904-1918), the African west coast excluding Gabon (1909-1920), the African east coast excluding Madagascar (1908-1918), and Gabon (1910-1912) (Fig. 5A-D). Results of simple regression of CPUE against total catch suggest initial stock sizes of 34,700 for the Falkland Island Dependencies, 13,600 and 8,600 for the African west (excluding Gabon) and east Coasts (excluding Madagascar) respectively, and 8,400 for the whaling grounds of Gabon. Given the biases in CPUE indices and the crude nature of the effort, these estimates should be regarded with caution. The open nature of the populations in consideration would result in these estimates being biased upwards.

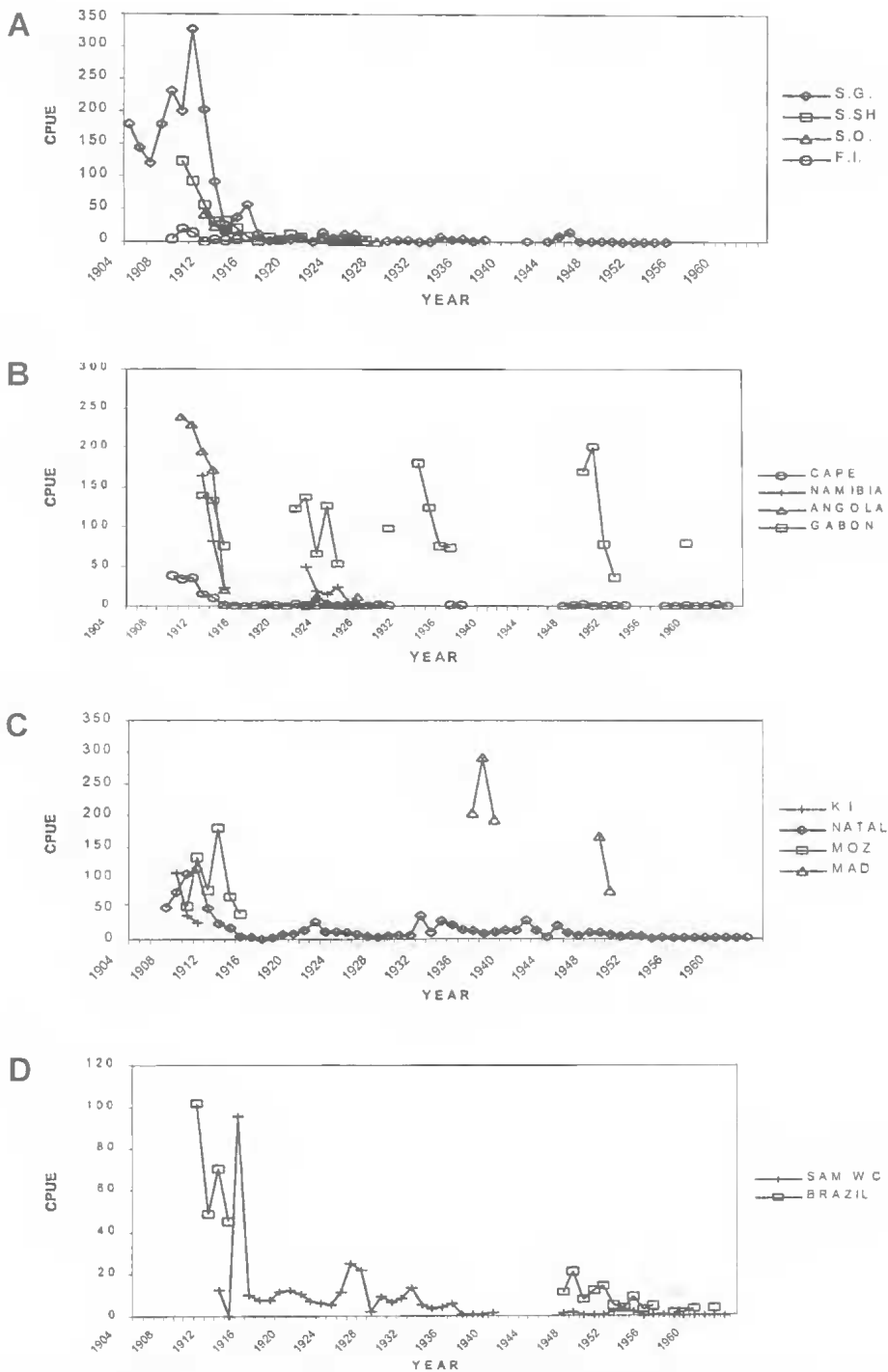


FIG. 4. Annual catch per number of catcher vessels (CPUE) from modern whaling grounds off: A, Falkland Island Dependencies; B, southern African west coast; C, southern African east coast and Kerguelen Island; and D, South American coasts. S.G. = South Georgia; S. SH. = South Shetland Islands; S.O. = South Orkney Islands; F.I. = Falkland Islands; K.I. = Kerguelen Island; MOZ. = Mozambique; MAD. = Madagascar; SAM. W.C. = South American West Coast.

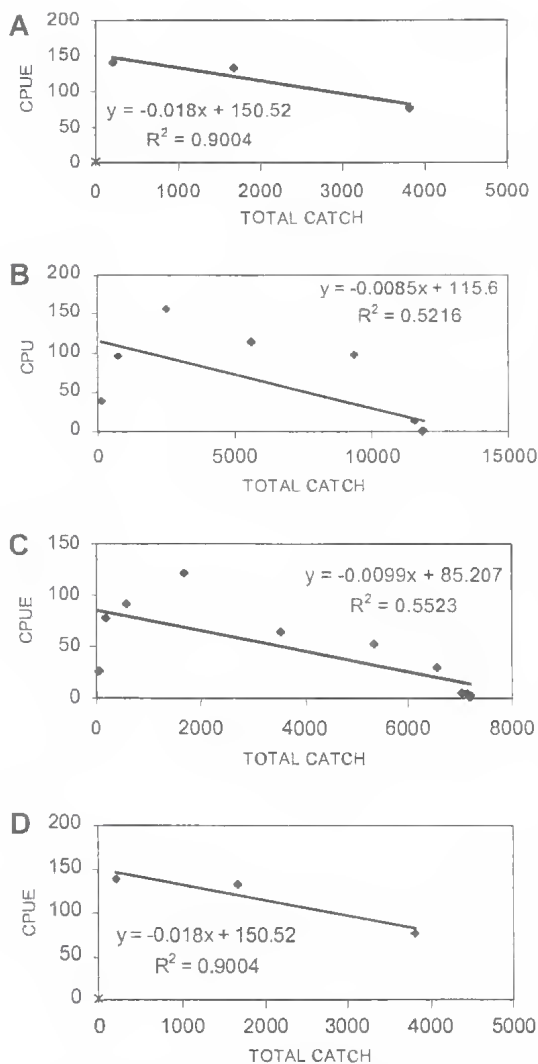


FIG. 5. Simple regression of catch per unit effort (CPUE) against total catch for: A, Falkland Island Dependencies 1904-1918; B, African west coast (excluding Gabon) 1909-1920; C, African east coast (Natal and Mozambique) 1908-1918; and D, coast of Gabon 1912-1914.

DISCUSSION

Catches of Southern Hemisphere humpback whales by modern whaling since the beginning of the 20th Century amount to over 200,000 and can be divided into four major eras: 1) pre-1917 coastal whaling from shore stations and floating factories; 2) Antarctic pelagic catches reported to the BIWS; 3) post-1942 coastal catches largely centred in Australian and New Zealand waters;

and 4) other catches made by the *Olympic Challenger* and the Soviet Antarctic whaling fleets.

Catch trends of humpback whales in particular whaling grounds appear to follow two basic patterns. In multi-species whaling grounds (where humpback whales would have been taken non-selectively, or grounds where humpback whales were caught elsewhere during migration), catch per unit effort declined markedly in the initial years and remained low until the cessation of whaling. However, in single species grounds (where catch effort was only directed at humpback whales), catches per unit effort may have declined to levels where whaling was no longer economically viable, leading to the closure of operations. In such species whaling grounds (e.g. off Gabon and possibly Madagascar) the closure of whaling appeared to allow some stock recovery.

Of particular interest is the difference between the catch series off Gabon and other locations on the west coast of Africa. Catches off the Cape, Namibia and Angola (as multi-species grounds or where humpback whales migrated through other whaling areas) declined markedly in the initial years of whaling and remained low until the IWC ban in October 1963. Catches off Gabon, however, declined in the initial period and as a single species whaling ground, the decline in humpback catches resulted in closure of operations. It appears that such closure allowed some recovery of the Gabon 'stock' and whaling resumed, again resulting in declines. CPUE indices from the end of each of the four whaling periods on the Gabon grounds have been projected at 10% per annum to the commencement of the next periods (Fig. 6). These projections suggest that recovery of the Gabon population, in each of the four successive eras, may well have been similar to increase rates of about 10% described elsewhere in the Southern Hemisphere (Paterson & Paterson 1989; Paterson et al. 1994, 2001; Bannister, 1994; IWC, 1996). Four such cycles are apparent in the Gabon catch history, but not in the catch histories from the other grounds on the west coast of southern Africa. Possibly whales from Gabon did not migrate through other grounds or to the Antarctic, suggesting possible stock segregation of humpback whales in this region. If so, then the question remains as to where humpback whales that winter on the Gabon grounds migrate to in summer. Summer incidence of humpback whales on temperate or tropical and sub-tropical low latitude feeding grounds associated with

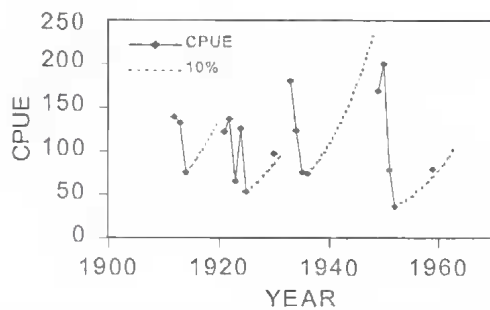


FIG. 6. Projection of a 10% increase in catch per unit effort indices from the whaling grounds off Gabon from the end of each whaling period to the initiation of the next.

upwelling areas has been noted (Papastavrou & van Waerebeek, 1997; Findlay & Best, 1995). Although no summer records of humpback whales could be sourced for the area, upwelling does occur in the Gulf of Guinea and in the region of the mouth of the Congo River.

Similarly, there appears to be considerable difference in the CPUE indices between the Mozambique (and KwaZulu-Natal, as Mozambique humpback whales are assumed to pass through the Durban whaling grounds en route to and from Mozambique) and Madagascar whaling grounds suggesting some stock segregation within the southwestern Indian Ocean. Best et al. (1998) noted that humpback whale catches off the Durban and Mozambique whaling grounds had declined by 1915, yet Angot (1951) noted that by the end of the 1950 whaling season, stocks around Madagascar had been significantly reduced to such an extent that commercial exploitation was no longer viable.

LITERATURE CITED

- ANGOT, M. 1951. Rapport Scientifique Sur Le Expéditions Baleinières Autour de Madagascar. (Saisons 1949 et 1959) Memiors de l'institut scientifique de Madagascar VI(2): 439-486.
- BARTHELMESS, K., KOCK, K-H. & REUPKE, E. 1997. Validation of catch data of the Olympic Challenger's whaling operations from 1950/51 to 1955/56. Report of the International Whaling Commission 47: 937-940.
- BANNISTER, J.L. 1994. Continued increase in humpback whales off Western Australia. Report of the International Whaling Commission 44: 309-310.
- BEST, P.B. 1994. A review of the catch statistics for modern whaling in Southern Africa, 1908-1930. Report of the International Whaling Commission 44: 467-485.
- BEST, P.B. & ROSS, G.J.B. 1989. Catches of right whales from shore-based establishments in southern Africa, 1792-1975. Report of the International Whaling Commission (special issue 10): 275-289.
- BEST, P.B., FINDLAY, K.P., SEKIGUCHI, K., PEDDEMORS, V.M., RAKOTONIRINA, B., ROSSOUW, A. & GOVE, D. 1998. Winter distribution and possible migration routes of humpback whales, *Megaptera novaeangliae* in Southwest Indian Ocean. Marine Ecology Progress Series 162: 287-299.
- BUREAU FOR INTERNATIONAL WHALING STATISTICS, 1942-1964. Records of the Bureau for International Whaling Statistics, Sandjeford, Norway.
- BUDKER, P. 1954. Whaling in French Overseas territories. Norsk Hvalfangst-Tidende 41: 320-325.
- BUDKER, P. & COLLIGNON, J. 1952. Trois campagnes baleinières au Gabon 1949-1950-1951. Bulletin Institut d' Etudes Centrafricaines Nouvelle Serie 3: 75-100.
- CHAPMAN, D.G. 1974. Status of Antarctic rorqual whale stocks. Pp 218-238. In Scheville, W.E. (ed.) The whale problem, a status report. (Harvard University Press: Massachusetts).
- CHITTLEBOROUGH, R.G. 1965. Dynamics of two populations of the humpback whale, *Megaptera novaeangliae* (Borowski). Australian Journal of Marine and Freshwater Research 16: 33-128.
- DAWBIN, W.H. 1956. The migrations of humpback whales which pass the New Zealand coast. Transactions of the Royal Society of New Zealand 83: 147-196.
- DE LURY, D.B. 1947. On the estimation of biological populations. Biometrics 3: 145-167.
- FINDLAY, K.P. & BEST, P.B. 1995. Summer incidence of humpback whales on the west coast of South Africa. South African Journal of Marine Science 15: 279-282.
- GOODALL, T.B. 1913. With the whalers off Durban, and a few notes on the anatomy of the humpback whale (*Megaptera boops*). Zoologist, 4th Ser. 17: 201-211.
- GRADY, D. 1982. The Perano whalers of Cook Strait 1911 - 1964. (A.H. & A.W. Reed: Wellington).
- HARMER, S.F. 1929. History of whaling. Proceedings of the Linnean. Society, London 140 (1927-28): 51-59.
1931. Southern whaling. Proceedings of the Linnean. Society, London Session 142: 1929-30, Pres. Add. :85-163.
- HINTON, M.A.C. 1925. Report on the papers left by the late Major Barrett-Hamilton, relating to the whales of South Georgia. (Crown Agents for the Colonies: London).
- INTERNATIONAL WHALING COMMISSION, 1996. Forty-sixth Report of the International Whaling Commission. (The International Whaling Commission: Cambridge).

1997. Forty-seventh Report of the International Whaling Commission. (The International Whaling Commission: Cambridge).
1998. Forty-eighth Report of the International Whaling Commission. (The International Whaling Commission: Cambridge).
- KELLOGG, R. 1929. What is known of the migrations of some of the whalebone whales. Reports of the Smithsonian Institution 1928: 467-494.
- MACKINTOSH, N.A. 1942. The southern stocks of whalebone whales. Discovery Reports 22: 197-300.
- MACKINTOSH, N.A. & BROWN, S.G. 1956. Preliminary estimates of the southern populations of the larger baleen whales. Norsk Hvalfangst-Tidende 9: 469-480.
- MATTHEWS, L.H. 1938. The humpback whale, *Megaptera nodosa*. Discovery Reports 17: 7-92.
- OLSEN, Ø. 1915. Hvaler og hvalangst i Sydafrika. Bergerns Museum. Arbok 1914-1915 5: 1-56.
- OMMANEY, F.D. 1933. Whaling in the Dominion of New Zealand. Discovery Reports 7: 239-252.
- OMURA, H. 1973. A review of pelagic whaling operations in the Antarctic based on the effort and catch data in 10° squares of latitude and longitude. Scientific Reports of the Whale Research Institute. Tokyo 25: 105-203.
- PAPASTAVROU, V. & VAN WAEREBEEK, K. 1997. A note on the occurrence of humpback whales (*Megaptera novaeangliae*) in tropical and sub-tropical areas: the upwelling link. Report of the International Whaling Commission 47: 945-947.
- PATERSON, R. & PATERSON, P. 1989. The status of the recovering stock of humpback whales *Megaptera novaeangliae* in east Australian waters. Biological Conservation. 47: 38-48.
- PATERSON, R., PATERSON, P. & CATO, D. 1994. The Status of humpback whales *Megaptera novaeangliae* in east Australian thirty years after whaling. Biological Conservation 70: 135-142.
2001. Status of humpback whales *Megaptera novaeangliae* in east Australia at the end of the 20th century. Memoirs of the Queensland Museum 47(2): 579-586.
- RAYNER, G.W. 1940. Whale marking : progress and results to December 1939. Discovery Reports 19: 245-284.
- RISTING, S. 1912. Knolhvalen. Norsk FiskTid. 31: 437-49. (Translation in Hinton, M.A.C. 1925. Report on the papers left by the late Major Barrett-Hamilton, relating to the whales of South Georgia. Crown Agents for the Colonies, London: 57-209).
- TØNNESSEN, J.N. & JOHNSEN, A.O. 1982. The history of modern whaling. (C. Hurst & Co.: London).
- WILLIAMSON, G.R. 1975. Minke whales off Brazil. Scientific Reports of the Whale Research Institute, Tokyo 27: 37-59.
- YABLOKOV, A.V. 1994. Validity of whaling data. Nature, London 367(6459): 108.
- ZEMSKY, V.A., MIKHALEV, Y.A. & TORMOSOV, D.D. 1997. Humpback whale catches by area by the Soviet Antarctic whaling fleets. Report of the International Whaling Commission 47: 151.